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Fluorescent silicon carbide is a promising candidate for efficient light conversion in all-semiconductor light-emitting devices [1, 2]. For these applications, fluorescent SiC needs to be grown on low off-axis substrates. The low off-axis is a requirement for the subsequent growth of a nitride excitation layer to avoid compositional effects that reduce excitation efficiency.

In this work we present growth and doping of fluorescent 4H-SiC layers on the Si-face of 4 degree off-axis substrates by sublimation epitaxy. The doped sources with nitrogen and boron concentrations in the 10^{18} cm^{-3} range were prepared by physical vapor transport (PVT) growth [3]. Sublimation epitaxy [4] employing doped and undoped sources was performed in different ambient from dynamic vacuum (i.e. with continuous pumping) to 0.5 mbar nitrogen background pressure.

The surface morphology was investigated by optical microscopy, scanning electron microscopy (SEM) and atomic force microscopy (AFM). Stable step flow growth was observed at a growth temperature of 1850°C and a growth rate of 150 µm/h using doped source and static vacuum. Under these conditions, 3C forms only at the edge from which step flow starts but no 3C-SiC inclusions are found in the step-flow region. However, 3C-SiC inclusions appeared in the step flow region when using undoped sources in dynamic vacuum (Fig. 1 a). This could be due to the higher supersaturation which is indicated by the higher growth rate in dynamic vacuum.

The typical surface morphology can be seen in Fig. 1 b. The steps are quite straight and no morphological instabilities as reported by Ohtani et al. [5] as an effect of nitrogen doping are observed. Step heights and step widths determined by AFM measurements are shown in Fig. 2 a. The step bunching shows a similar relationship and no pronounced shift with the nitrogen concentration in the source.

The photoluminescence (PL) spectra (Fig. 2 b) show a broad band luminescence from donor-acceptor pair recombination. Compared to fluorescent 6H-SiC layers, the peak is shifted due to the different bandgaps. The yet unassigned additional peak in PL from fluorescent 6H-SiC layers on the longer wavelength side is absent or much less pronounced in PL spectra from fluorescent 4H-SiC.

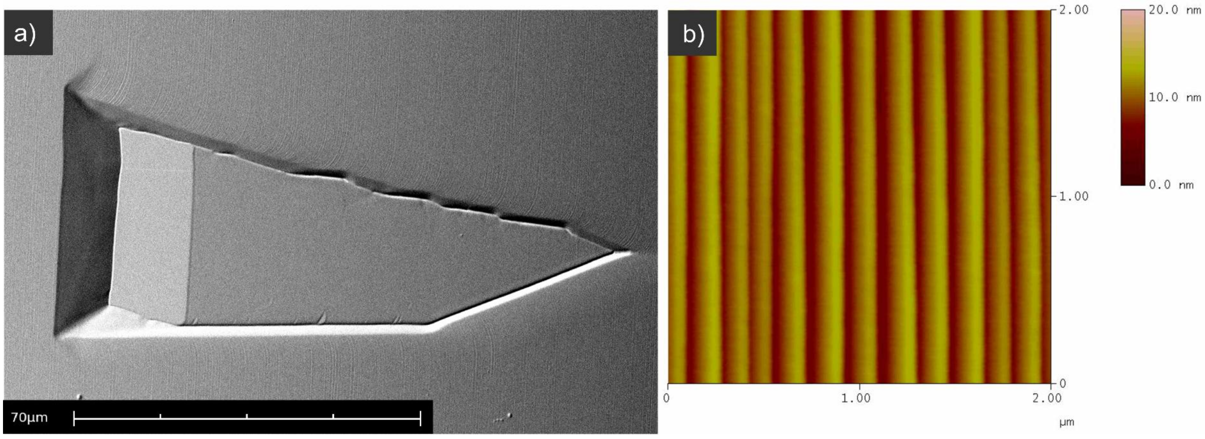

Fig. 1 a) 3C inclusion in the step flow region of a layer grown in dynamic vacuum with undoped source (SEM), b) Macrosteps on a layer grown in static vacuum (AFM)

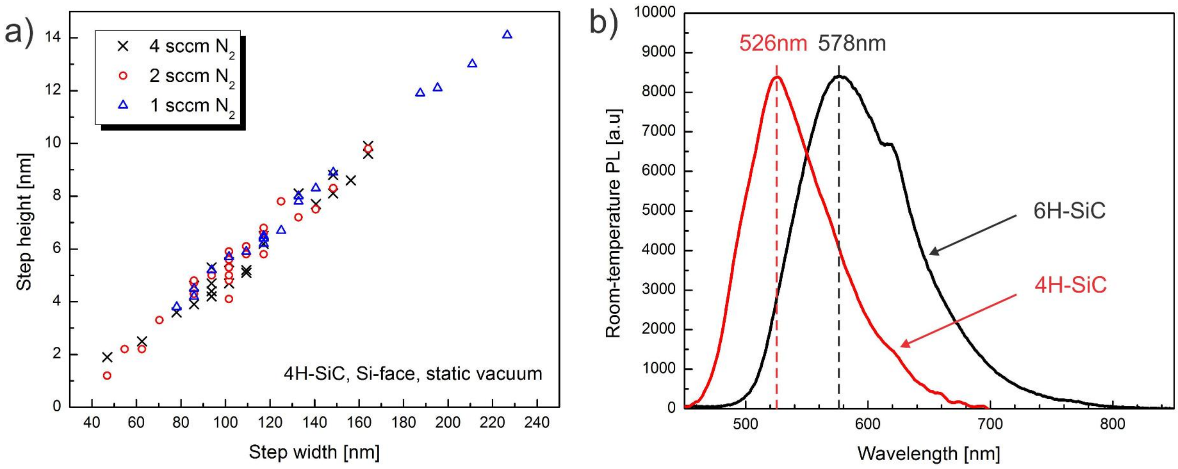

Fig. 2 a) Step heights and step widths determined by AFM from layers grown with PVT sources containing different amounts of nitrogen (expressed as N_2 flow applied during PVT growth), b) Room-temperature PL spectra showing donor-acceptor pair luminescence of 4H-SiC and 6H-SiC (intensity normalized)

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